IDA

NEC2 Effectiveness and Agility:
Analysis Methodology, Metrics, and Experimental Results*

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MORS Workshop
Joint Framework for Measuring c2 Effectiveness
Working Group 4: Analysis of Human Decision Making in a Networked Environment
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Agenda

- Presentation Objectives

- Agility 101

- C2 Agility Experiments

- Selected Results

- Conclusions

Presentation Objectives

- MORS Workshop Topic
  - Measuring C2 Effectiveness
- WG 4 Focus
  - Human Decision Making in a Networked Environment
- Presentation Objectives
  - Explain why measuring C2 Effectiveness is insufficient
  - Introduce Agility and C2 Agility
  - Present results of ELICIT C2 Agility Experiments
  - Demonstrate ability to measure effectiveness / agility of distributed decision making in a networked environment
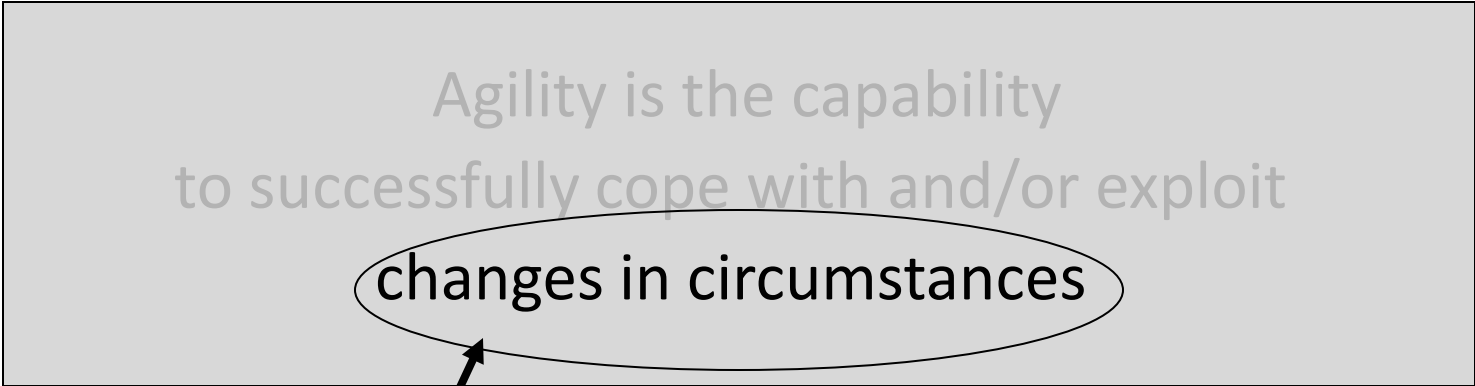
Agility 101

- What do you mean by Agility?

- Why is Agility an imperative?

- What is an *agile* enterprise?

- How can one measure and visualize Agility?

Source: DoD CCRP

What is Agility?

Agility is the capability
to successfully cope with and/or exploit
changes in circumstances

Source: DoD CCRP

What is Agility?

Agility is the capability
to successfully cope with and/or exploit

changes in circumstances

- the concept of Agility does not apply to a stable situation
- external changes (e.g. mission, adversary tactics, permissive to hostile environment)
- changes to self (e.g. new coalition partners, network damage / loss of capability)

Source: DoD CCRP

What is Agility?

Agility is the capability
to successfully cope with and/or exploit
changes in circumstances

successfully

within acceptable bounds of performance
(e.g. effectiveness, efficiency, risk)

Source: DoD CCRP

What is Agility?

Agility is the capability
to successfully (cope) with and/or (exploit)
changes in circumstances

respond to an event that would otherwise have adverse consequences

take advantage of an opportunity to improve effectiveness and/or efficiency or reduce risk

Enablers of Agility

- Responsiveness

- Versatility

- Flexibility

- Resilience

- Adaptiveness

- Innovativeness

Source: DoD CCRP

Agility 101

- What do you mean by Agility?

- **Why is Agility an imperative?**

- What is *agile* C2?

- How can one measure and visualize C2 Agility?

Source: DoD CCRP

Sources of Mission Complexity

21st Century Missions are *Complex Endeavors*

Complexity of the Task and Environment

+

Complexity of 'Self'

=

Complex Endeavor

Source: DoD CCRP

Complexity of Task and Environment

Humanitarian Assistance

Peace Keeping

Counter Terrorism

- The success of 21st Century Missions requires a multi-dimensional effects space
    - *political, social, economic, military*

- The complexity of the mission is a result of the interactions between and among the effects, particularly across dimensions, and the uncertainties associated with a cascading effects chain.
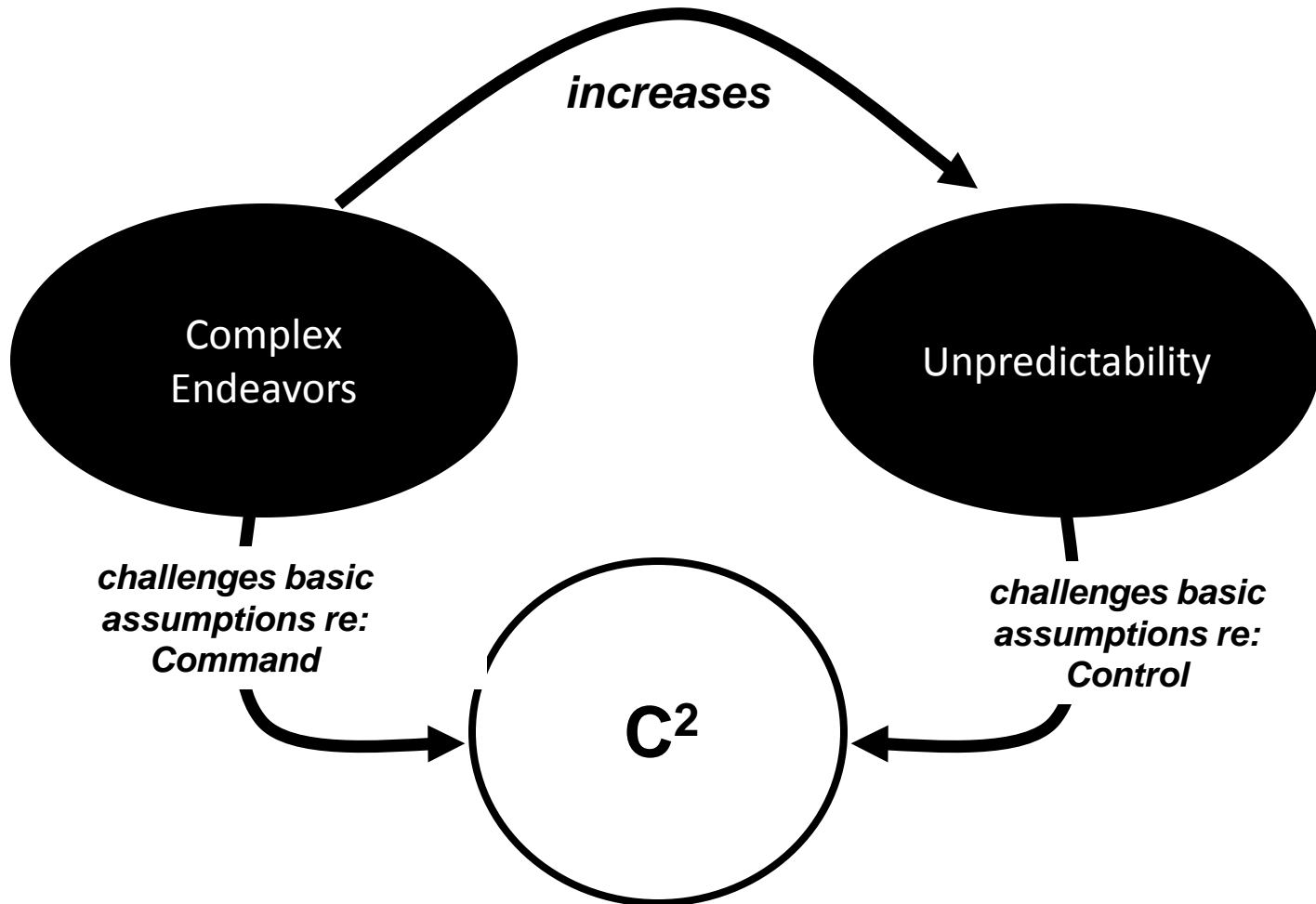
Disaster Relief

Stability Operations

Source: DoD CCRP

Complexity of Self

- Self = A large number of heterogeneous, independent entities that differ significantly with respect to:

  - Culture, values and norms;
  - Laws, policies, rules, and regulations;
  - Practices and processes;
  - Levels of trust;
  - Language;
  - Information and communications capabilities;
  - Approach to organization and management.

- The complexity of 'Self' comes from the nature of the interactions between and among the participating entities and the dynamics of the situation that affect entity willingness, constraints, perceptions, and capabilities.

Source: DoD CCRP

Implications for Command and Control

increases

Complex Endeavors

Unpredictability

challenges basic assumptions re: Command

challenges basic assumptions re: Control

C^2

Source: DoD CCRP

Challenges to Basic C2 Assumptions
Unpredictability

- Increased complexity will make the unexpected occur with greater frequency

- The effective lives of plans will be shorter – they may expire within the planning cycle.

- Critical information and expertise necessary to understand the situation will not be available

- Traditional approaches to decision making under uncertainty will be less applicable

> ***The most appropriate response to increased complexity and the associated increases in uncertainty and risk is Agility***

Source: DoD CCRP

Implications for Command and Control

Source: DoD CCRP
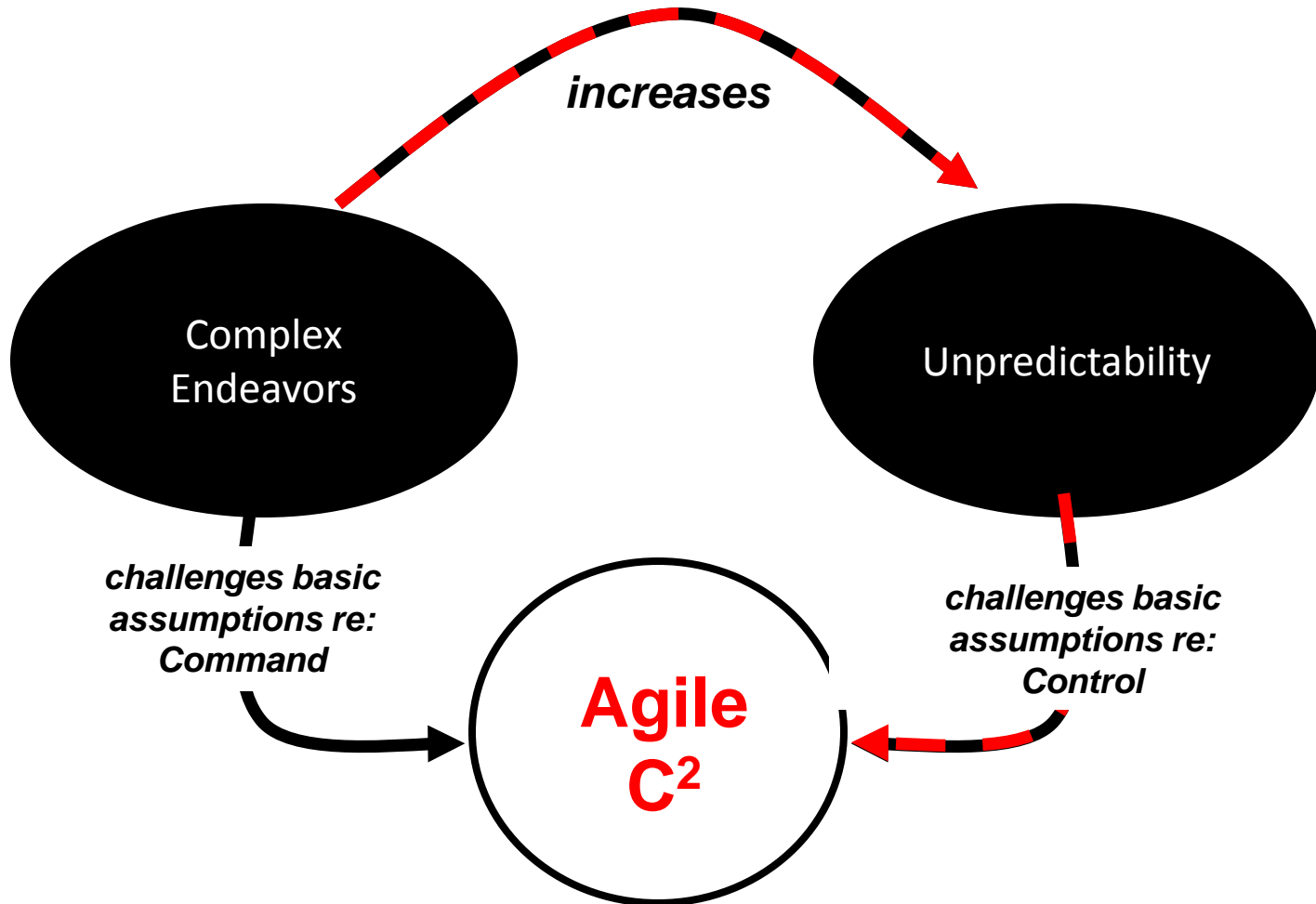
Challenges to Basic C2 Assumptions
Complex Endeavors

- There will not be a unified chain of command.
- Entities will each have their own intent.
- The situation will be, in part, unfamiliar to all entities.
- There will be multiple planning processes.
- Critical information and expertise necessary to understand the situation will be non-organic.
- Actions, to be effective, will require developing synergies between and among entity actions.

Complex Endeavors require new approaches to Entity C2 to achieve Collective Focus and Convergence
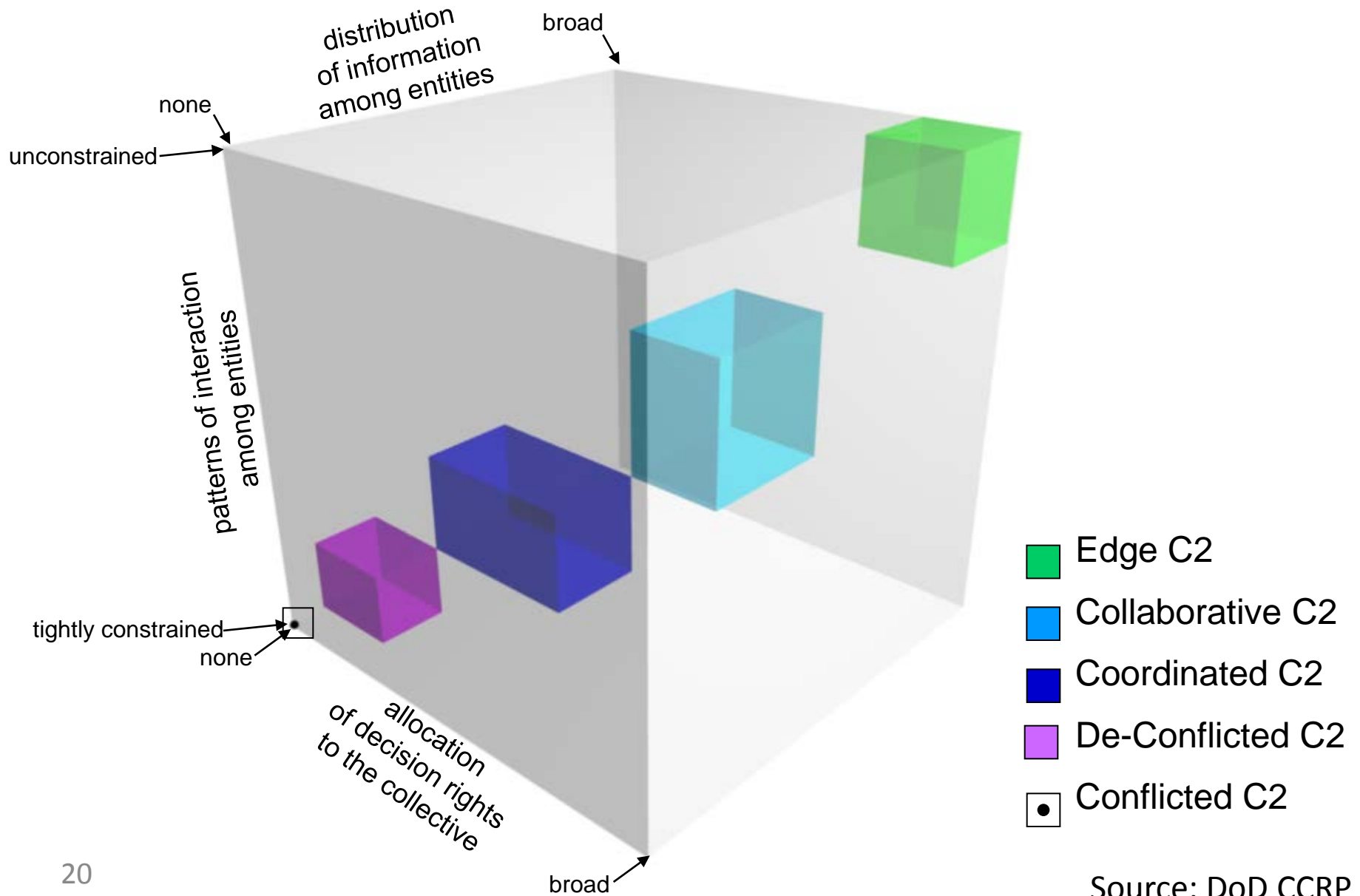
Source: DoD CCRP

Agenda

- What do you mean by Agility?

- Why is Agility an imperative?

- **What is *agile* C2?**

- How can one measure and visualize C2 Agility?

- If this is a journey, what is a good first step?
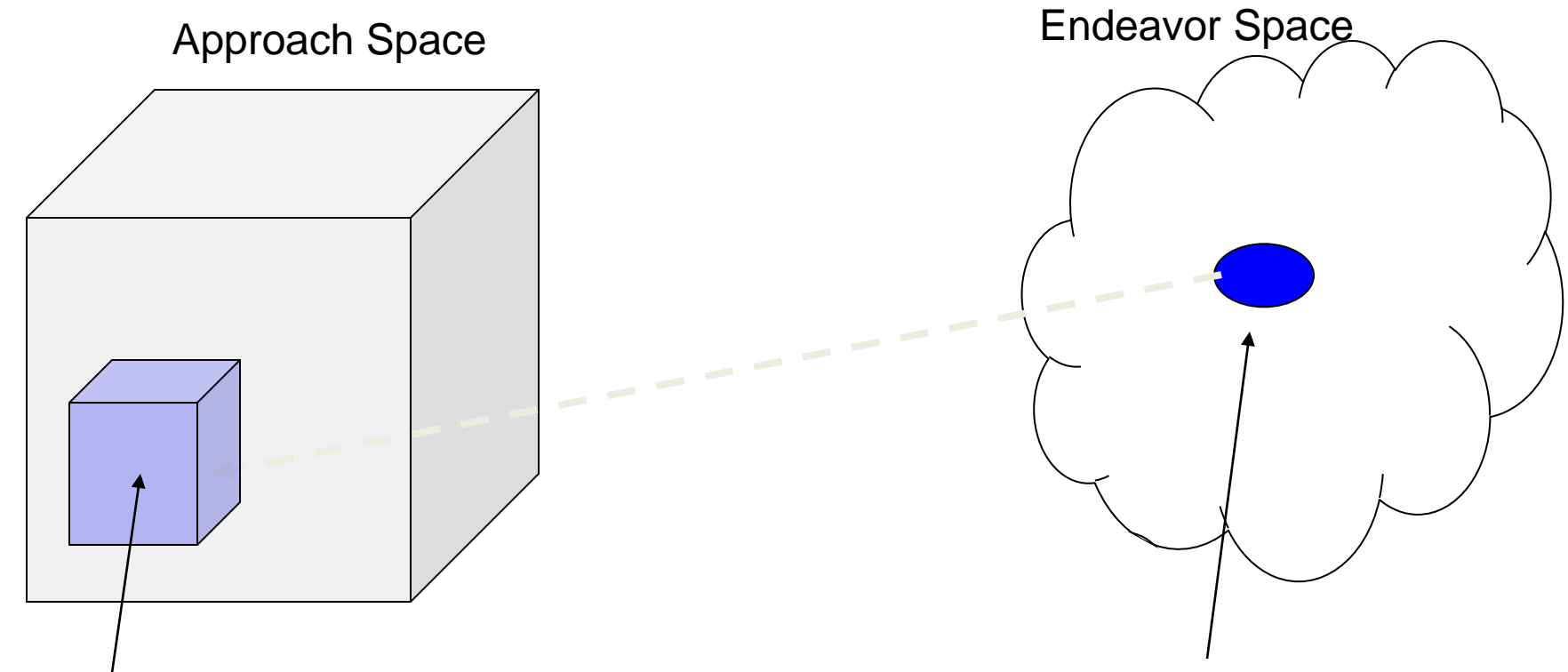
18

Source: DoD CCRP

C2 Agility

- There are *<u>many ways</u>* to accomplish the functions associated with Command and Control
- No one Approach fits all missions or situations
- The most appropriate approach will be a function of the endeavor and the prevailing circumstances
- Entities will need to be able to employ more than one approach
- C2 Agility is the ability to move around in the C2 Approach Space in response to changing missions and circumstances
- Agile C2 systems and processes are required for C2 Agility

Source: DoD CCRP

C2 Approach Space

Legend:
- Edge C2
- Collaborative C2
- Coordinated C2
- De-Conflicted C2
- Conflicted C2

20

Source: DoD CCRP

C2 Agility

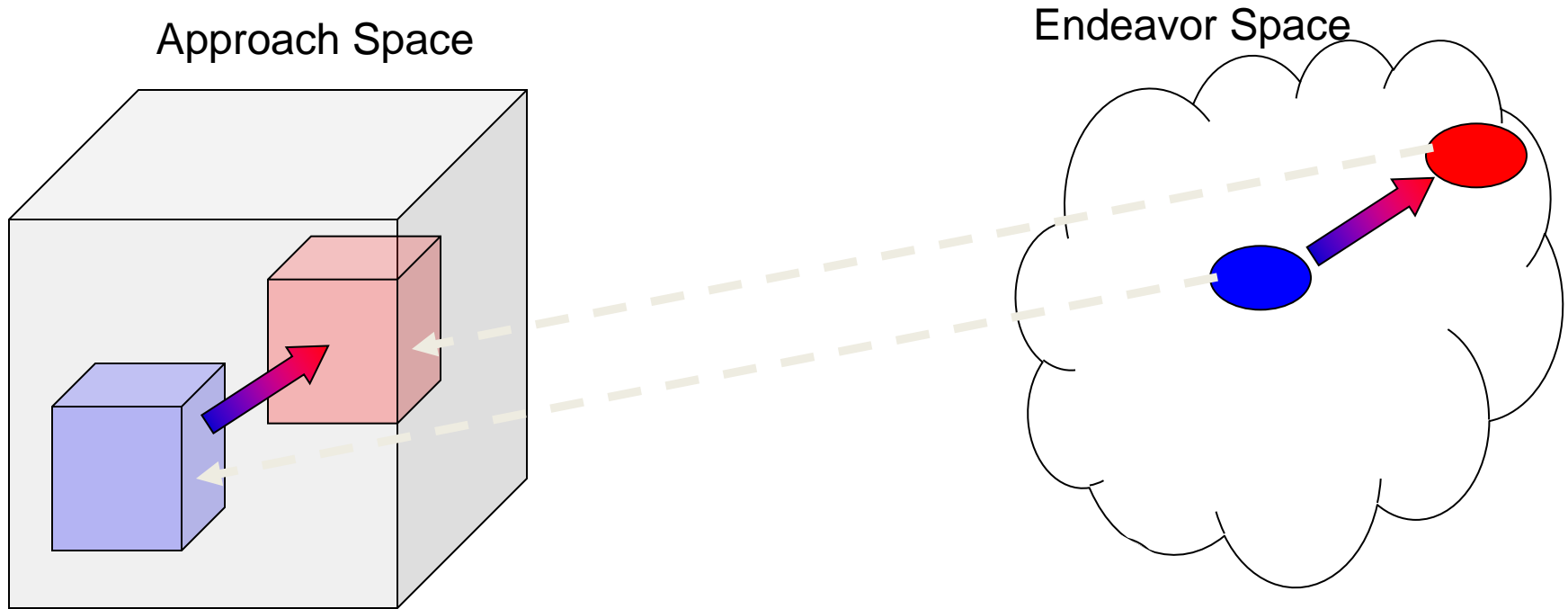Approach Space

Endeavor Space

This is a most appropriate C2 Approach for this particular set of circumstances

Source: DoD CCRP

C2 Agility

When circumstances change, a different approach might be more appropriate

Approach Space

Endeavor Space

C2 Agility involves recognizing the significant of a change in circumstances, understanding the most appropriate C2 Approach for the circumstance and being able to transition to this approach.

Source: DoD CCRP

Agenda

- What do you mean by Agility?

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- What is *agile* C2?
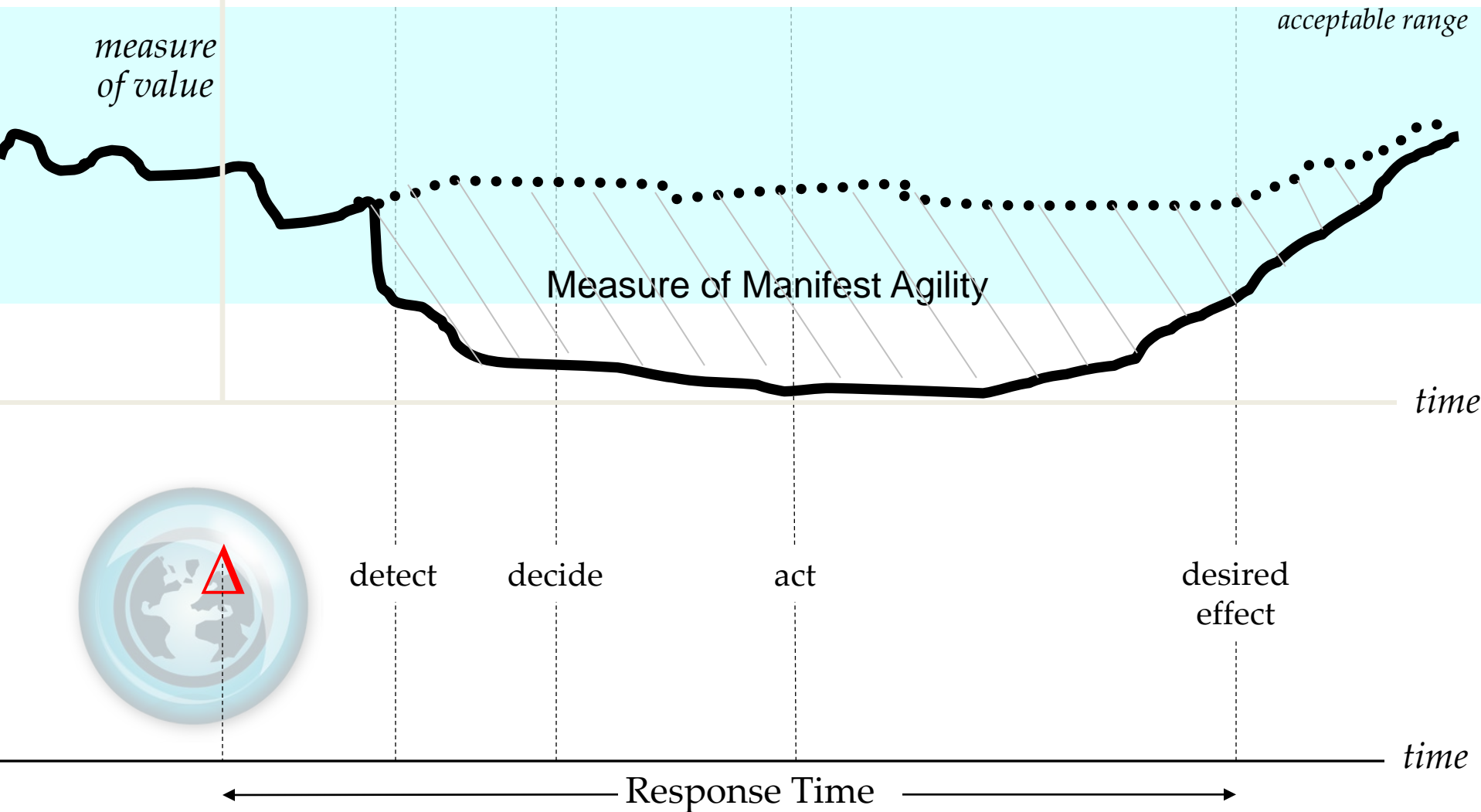
- **How can one measure and visualize C2 Agility?**

Source: DoD CCRP

Measuring Agility

- Manifested Agility v. Potential Agility

- Response Graph

- Agility Maps

- Impact Diagram

Source: DoD CCRP

Manifest v. Potential Agility

- **Manifest Agility**

  - a response to an event that has occurred
  - measuring Manifest Agility involves comparing what actually happened to what would have happened if no change had taken place

- **Potential Agility**

  - a capability that enables an entity to exhibit agile behaviors when required
  - measuring Potential Agility involves identifying indicants of agility

Source: DoD CCRP

Measuring Manifest Agility
Response Graph

measure of value

acceptable range

Measure of Manifest Agility

time

detect   decide   act   desired effect

time

Response Time

Source: Alberts, D.S. The Agility Imperative, 2010 Part IV: Understanding Agility

Entity Agility Map

An Entity Agility Map is a projection of entity performance onto an Endeavor Space

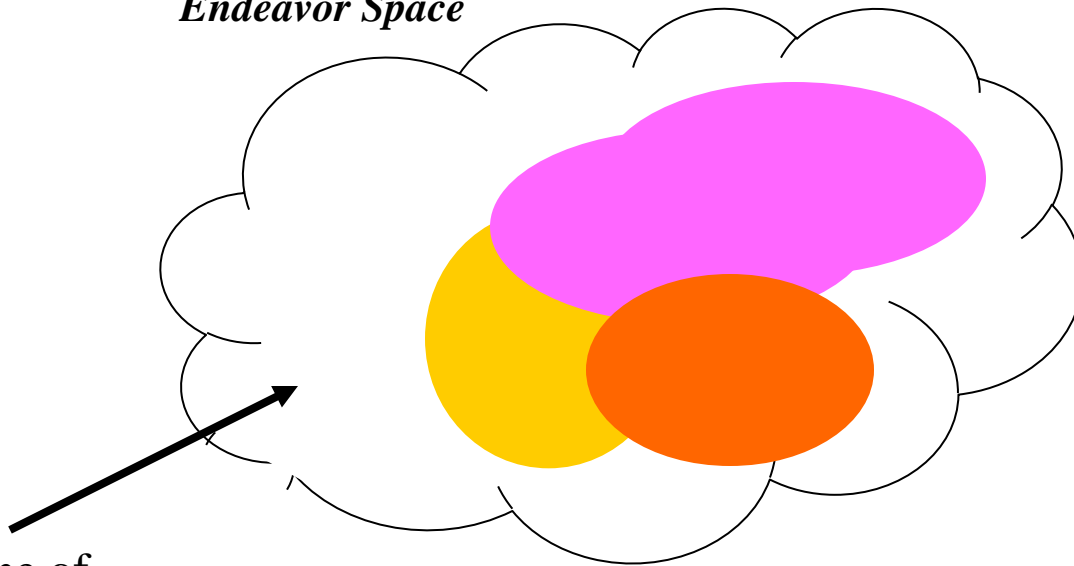*Endeavor Space*

regions where an entity can operate successfully
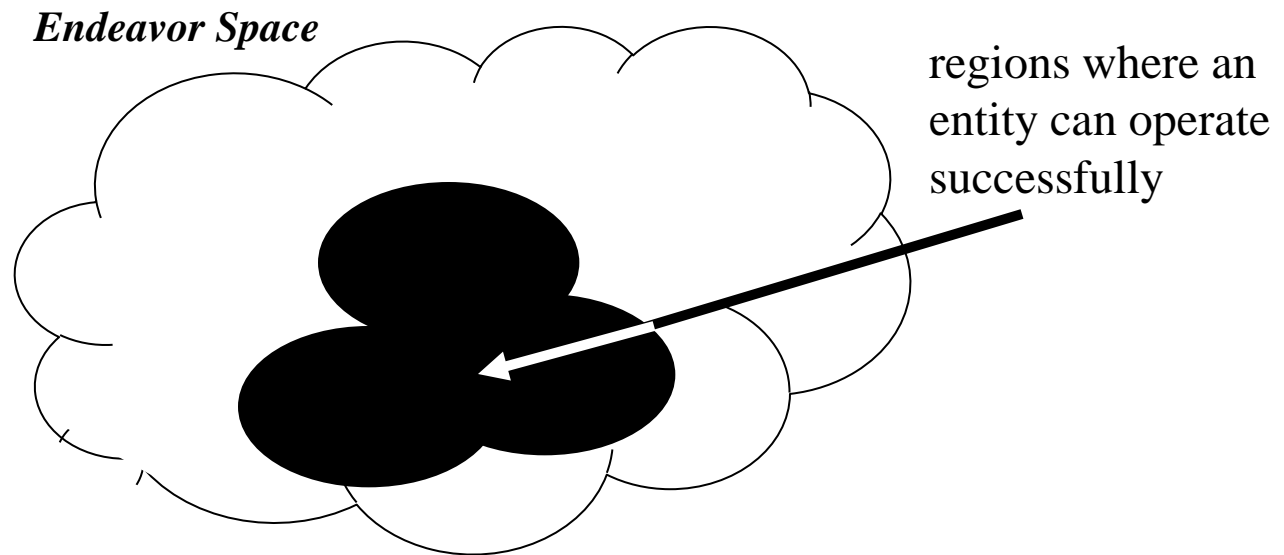
Endeavor Space is a multi-dimensional space consisting of regions that correspond to a set of endeavor characteristics and conditions

Source: DoD CCRP

Comparative Agility Map

A Comparative Agility Map shows the most efficient entity option for each region of Endeavor Space

Endeavor Space

regions where none of
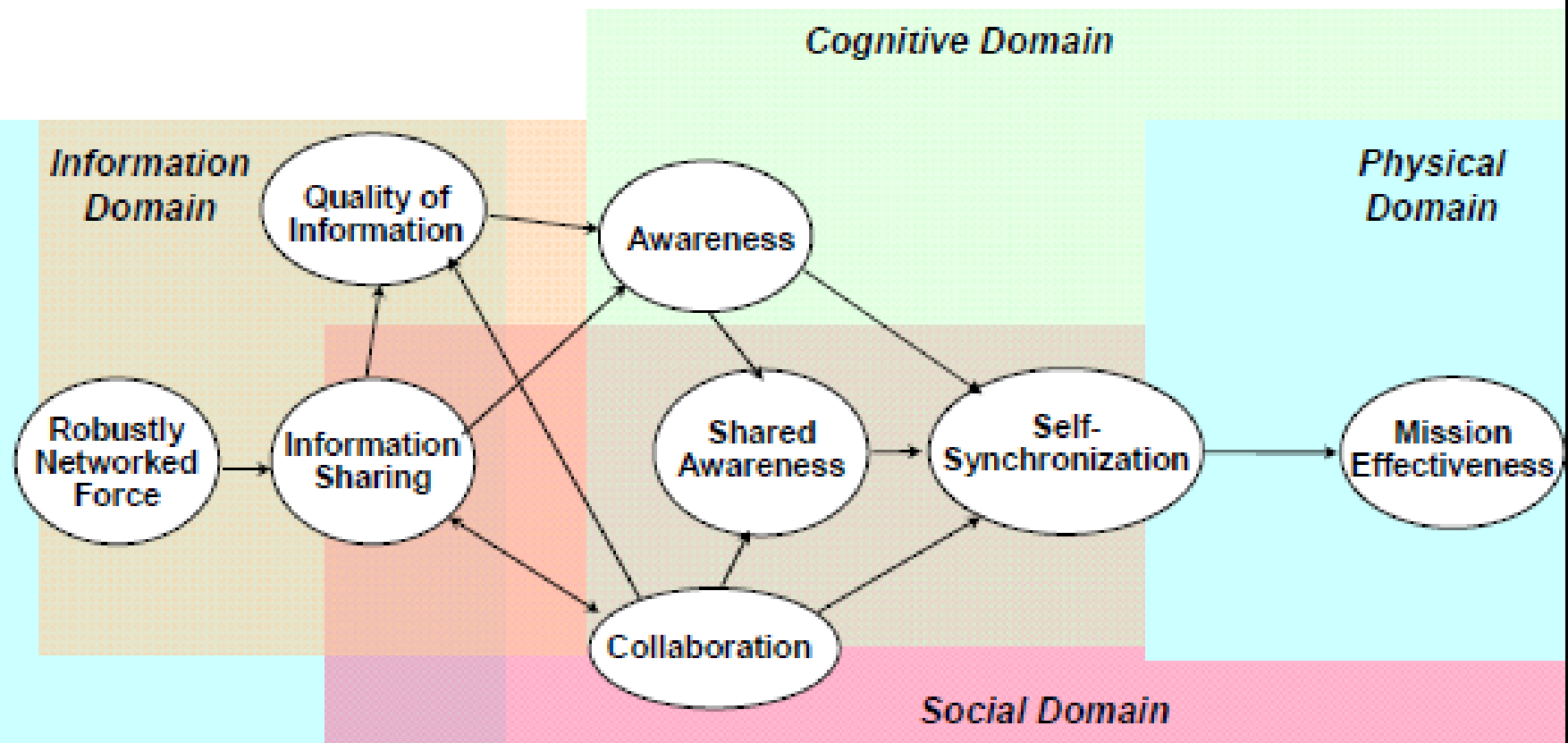the options are able to
operate successfully

Source: DoD CCRP

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- Agility 101

✓ C2 Agility Experiments

- Selected Results

- Conclusions

ELICIT C2 Agility Experiments

- Hypotheses
  - No one approach to C2 fits all missions /circumstances
  - More Network-Enabled C2 approaches are more agile
  - More mature C2 is more agile

- Experimental Environment
  - DoD CCRP developed Experimental Laboratory for the Investigation of Collaboration, Information sharing, and Trust
  - abELICIT is the agent-based version
  - Task = correct identification of the "who, what, when, where" of an attack

- Controllable Variables
  - Treatment :C2 Approach
  - Other : Mission Challenge, Problem difficulty, Information quality, etc.
  - Mission Requirements for Shared Awareness and Timeliness

- Metrics
  - Effectiveness = Satisfies mission requirements
  - Agility = Effectiveness over the range of missions, circumstances, conditions

Measuring Success (Effectiveness)

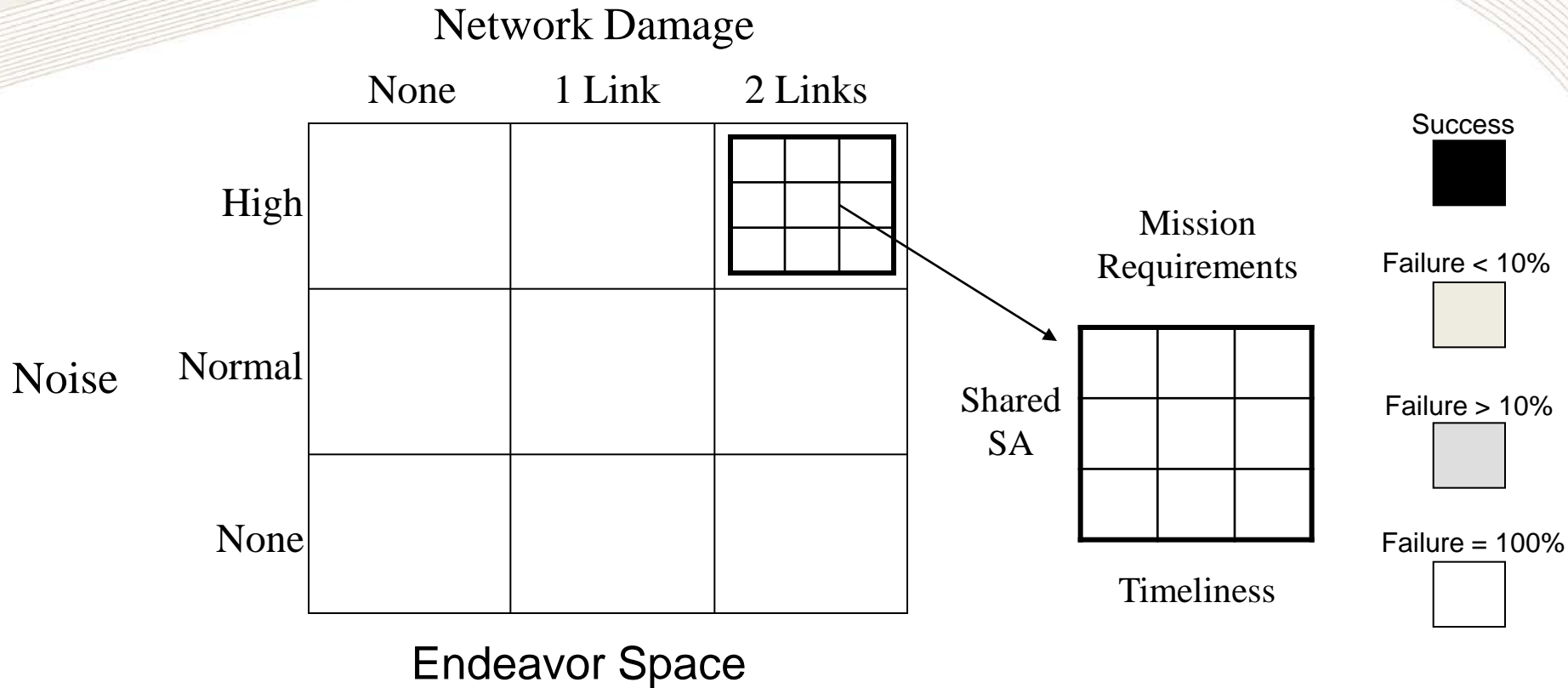# Measure of ELICIT Distributed Decision Making Task Effectiveness
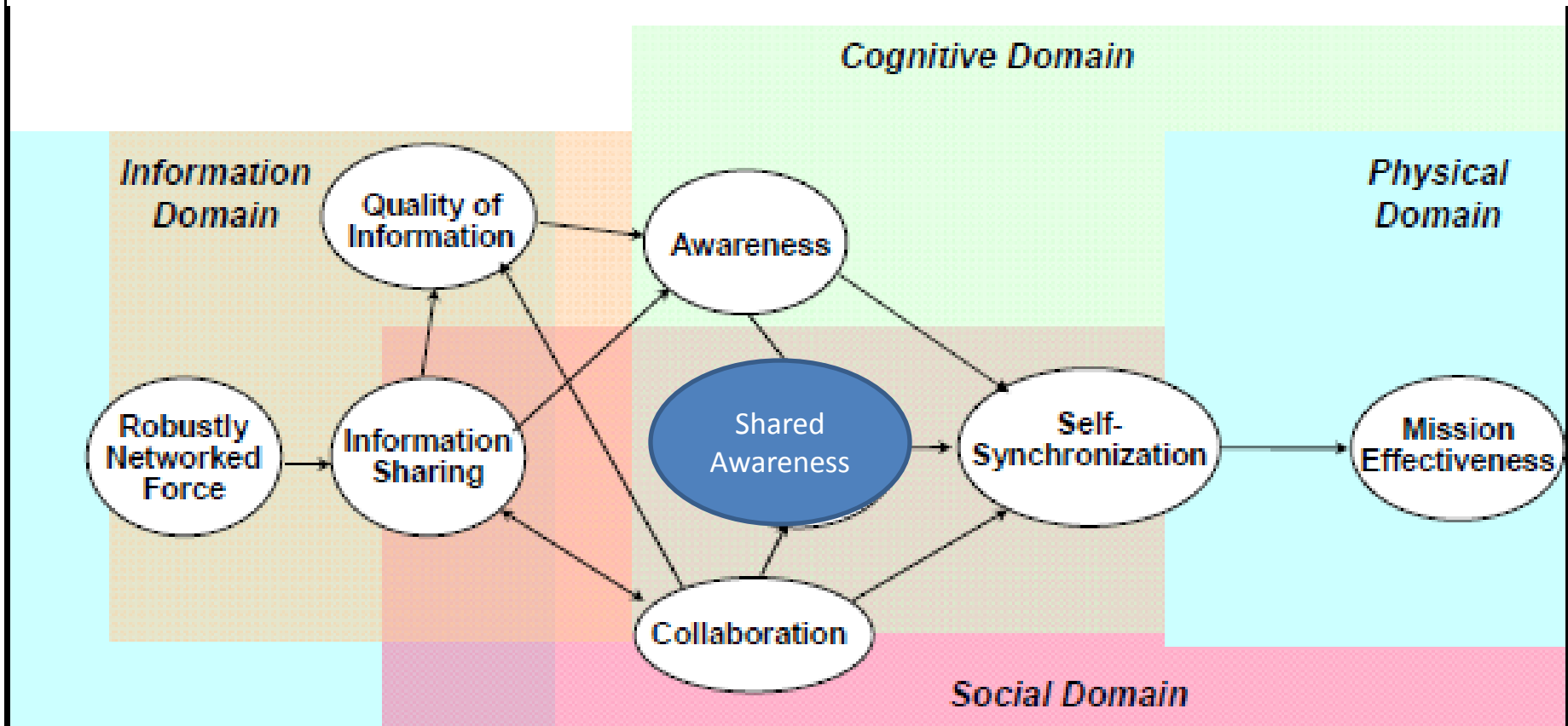
- Shared Awareness is the fulcrum that enables NEC2 to leverage the power of a robustly connected force – enable self-synchronization
- Shared Awareness is one measure of the quality of distributed human decision making

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Agility Map for Edge C2
## (with an adaptive information sharing policy)

Network Damage

Noise

Endeavor Space

with varying Signal-Noise Conditions and Degrees of Network Damage

Source: Alberts, D.S. The Agility Imperative, 2010 Part V: Agility Experiments

Agility Map for Edge C2
(with an adaptive information sharing policy)

Endeavor Space

with varying Signal-Noise Conditions and Degrees of Network Damage

Success ■

Failure < 10% ▣

Failure > 10% ▢

Failure = 100% □
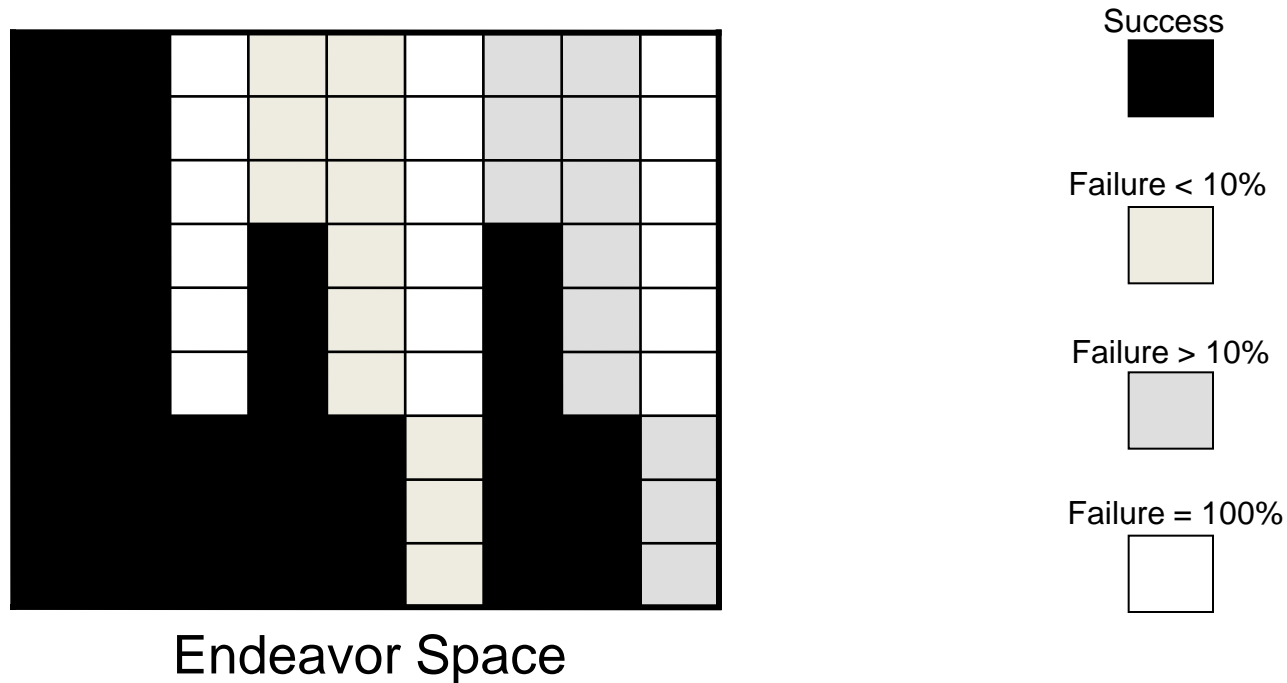
Comparative Agility Map
## for Organization-Approach options
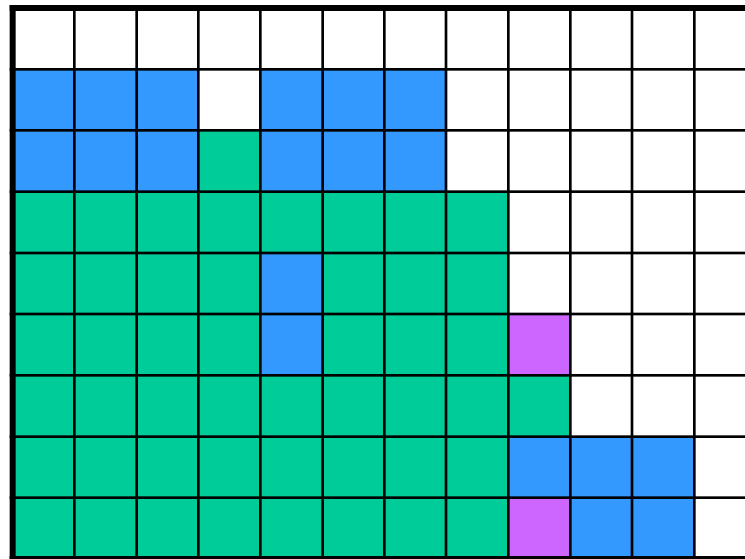
Endeavor Space

Organization Approach Options

- 🟩 Edge
- 🟦 Collaborative
- 🟦 Coordinated
- 🟪 De-conflicted

with varying conditions of signal to noise
and with varying requirements
for shared situation awareness and response time

Impact Diagram

Impact of Workload on Timeliness

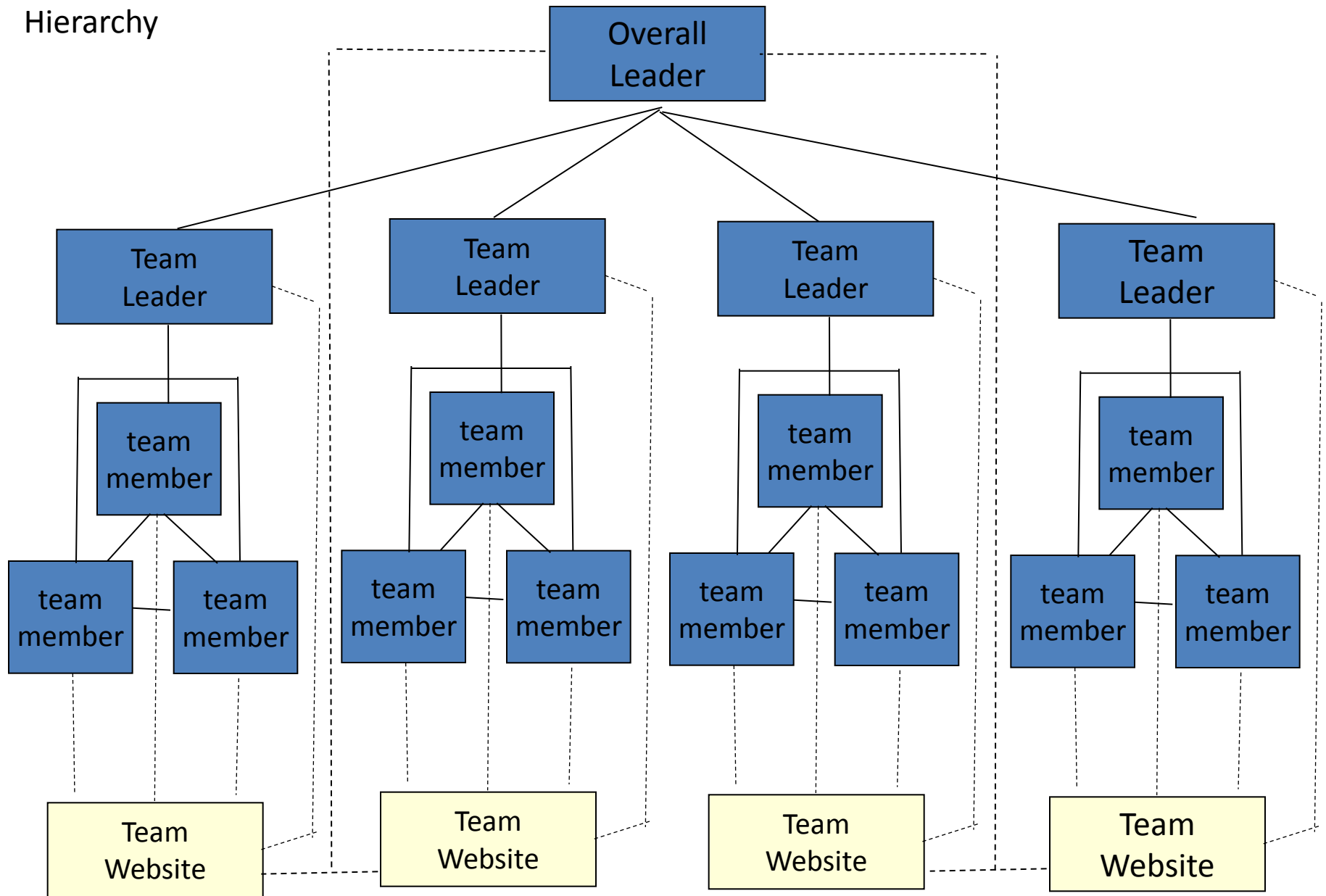Source: Alberts, D.S. The Agility Imperative, 2010 Part V: Agility Experiments
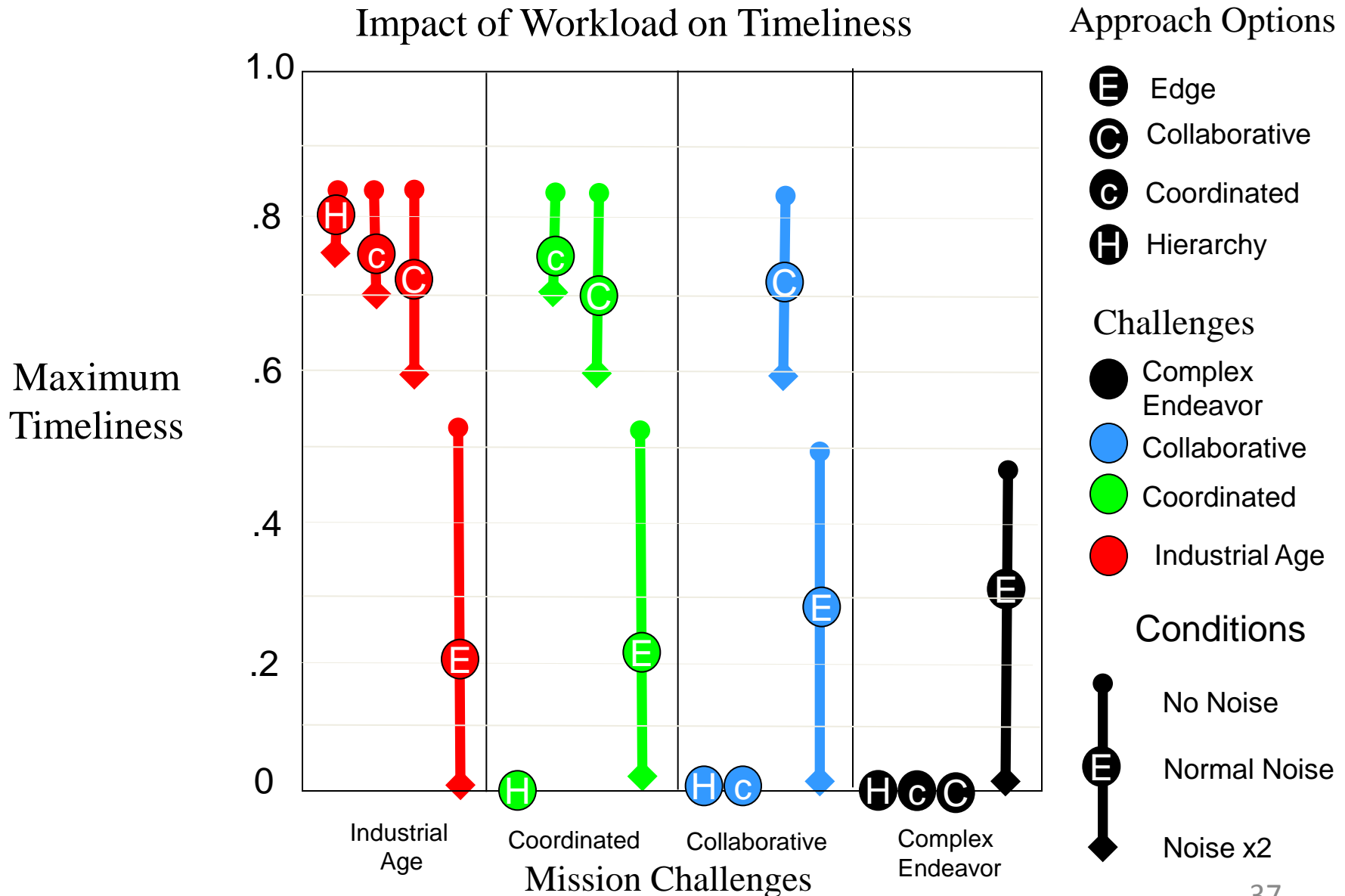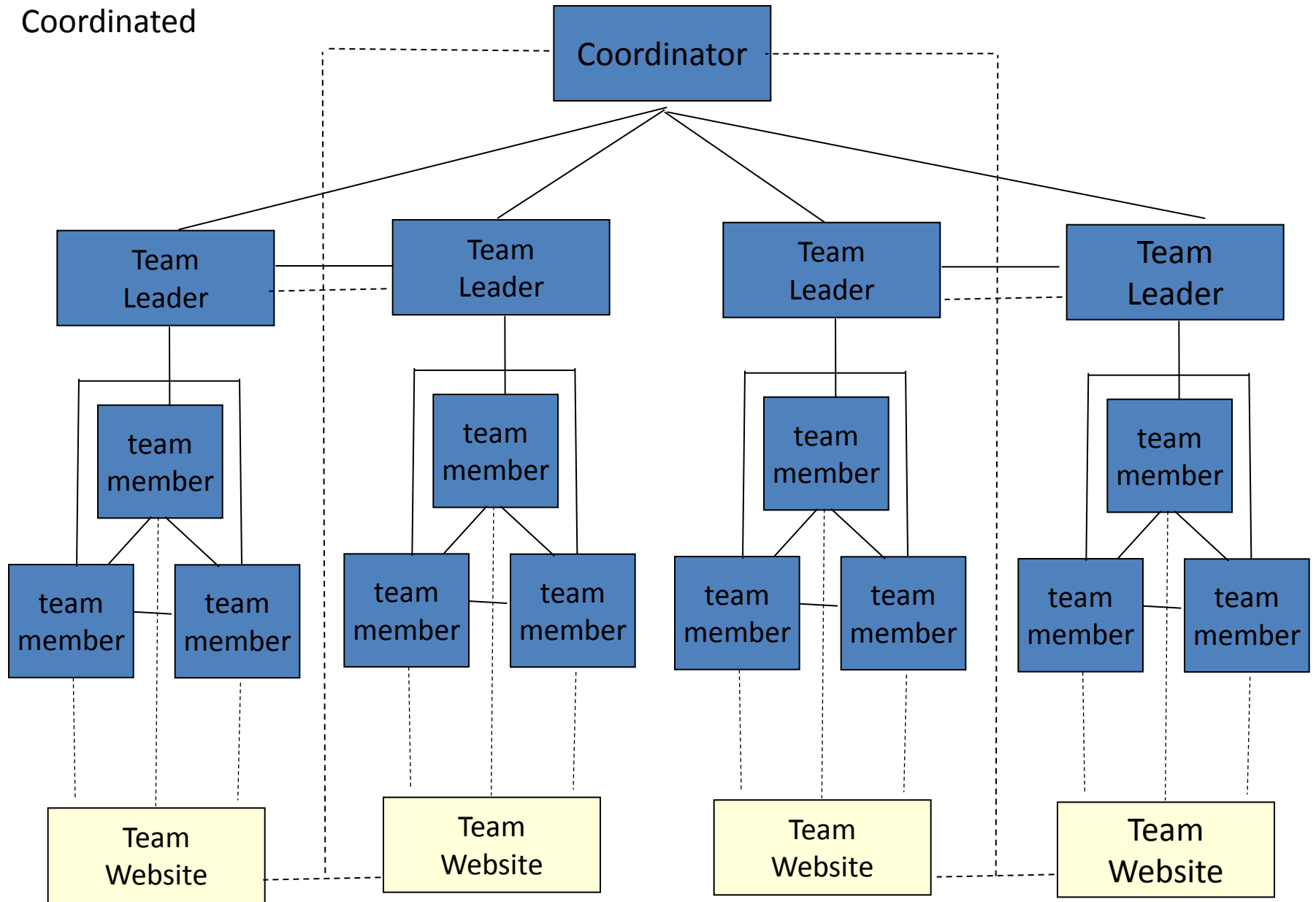
Conclusions

- A measure of Task Effectiveness alone is insufficient in a world where Complex Endeavors are the norm

- One size C2 does not adequately fit all missions and circumstances

- C2 Agility is an imperative

- We can measure C2 Agility well enough to start doing it

- We can design and conduct experiments that can explore the Agility of different approaches to C2 and the consequences of being able to appropriately employ different approaches as the situation changes

Hierarchy

```
                        ┌──────────────┐
                        │   Overall    │
                        │   Leader     │
                        └──────────────┘
```

Overall
Leader

Team Leader

Team Leader

Team Leader

Team Leader

team member

team member

team member

team member

team member

team member

team member

team member

team member

team member

team member

team member

Team Website

Team Website

Team Website

Team Website

Coordinated

Collaborative

Edge

42